

REVIEW

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Renewable, natural, traditional dish wash cleaning materials used in India: an overview

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Abstract

Background India has been using natural, renewable resources for dishwashing and cleaning since pre-Harappan times, which speak to the country's rich biodiversity and long standing traditions of health and hygiene. The current review focuses on several Indian traditional dish wash materials that are categorized according to their mechanism of action as scrubbers and scrappers, abrasives, degreasers, deodorizers and saponin biosurfactant dish wash cleaning materials.

Main body of the abstract Scrubbers and scrappers include rice straw, bagasse, coconut coir, coconut brooms, jute and agave fibers, luffa, etc. Soil, clay, sand, crystal salt, lime, rice husk, bran, starch, ash (wood, dung, husk), charcoal, biochar, and other materials are examples of abrasives. Materials that contain organic acids, such as citrus, mango, gooseberry, tamarind, tomato fruits, are used as degreasers. On the other hand, *Citrus* peels, drumstick seeds, sour butter milk, etc., come under deodorizers. The saponin biosurfactant rich fruits and seeds of soapnuts, soap pod, green gram, Bengal gram, bitter *Albizia*, etc., function as surface active agents. A few of them use multiple mechanisms to clean the vessels. They are used in many forms (solid, powder, liquid, paste, sponge, fiber, scrub, broom) and obtained from a variety of plant plants (leaf, bark, stem, fruit, seed) as well as the earth's crust.

Short conclusion Compared to commercial, manmade surfactants, natural organic and biosurfactant cleaners have several major advantages over synthetic ones, such as their natural availability, affordability, renewability, biocompatibility, biodegradability, minimal environmental and human toxicity, hypo-human allergenicity and multifaceted biological activities. They are free from preservatives and carcinogenic byproducts, free from phosphate-induced eutrophication and sustainable in terms of local resource use, fossil fuel independence and low carbon footprint production. In addition to kitchen utensil cleaning, few of them are utilized for their myriad of functionalities such as jewelry polisher, face mask, bathing soap, hair cleanser, hair conditioner and washing detergent. The use of renewable and natural cleaning materials aligns with several United Nations Sustainable Development Goals, including Goal 6, Goal 9, Goal 12, Goal 13, Goal 14 and Goal 15.

Keywords Abrasives, Degreaser, Deodorizer, Dish wash cleaner, India, Renewable, Saponin, Scrubber, Sustainable, Traditional

Background

India is well known for its gastronomy, traditional cookware, culinary techniques and skills; customs, traditions and rich cultural heritage. Exploitation of a variety of locally sourced, renewable materials is linked to economical, medical, culinary, cultural, environmental and religious benefits (Kora 2019a, b, 2020b). The current review briefs about the several natural, traditional dish wash cleaning materials that are available and used in India,

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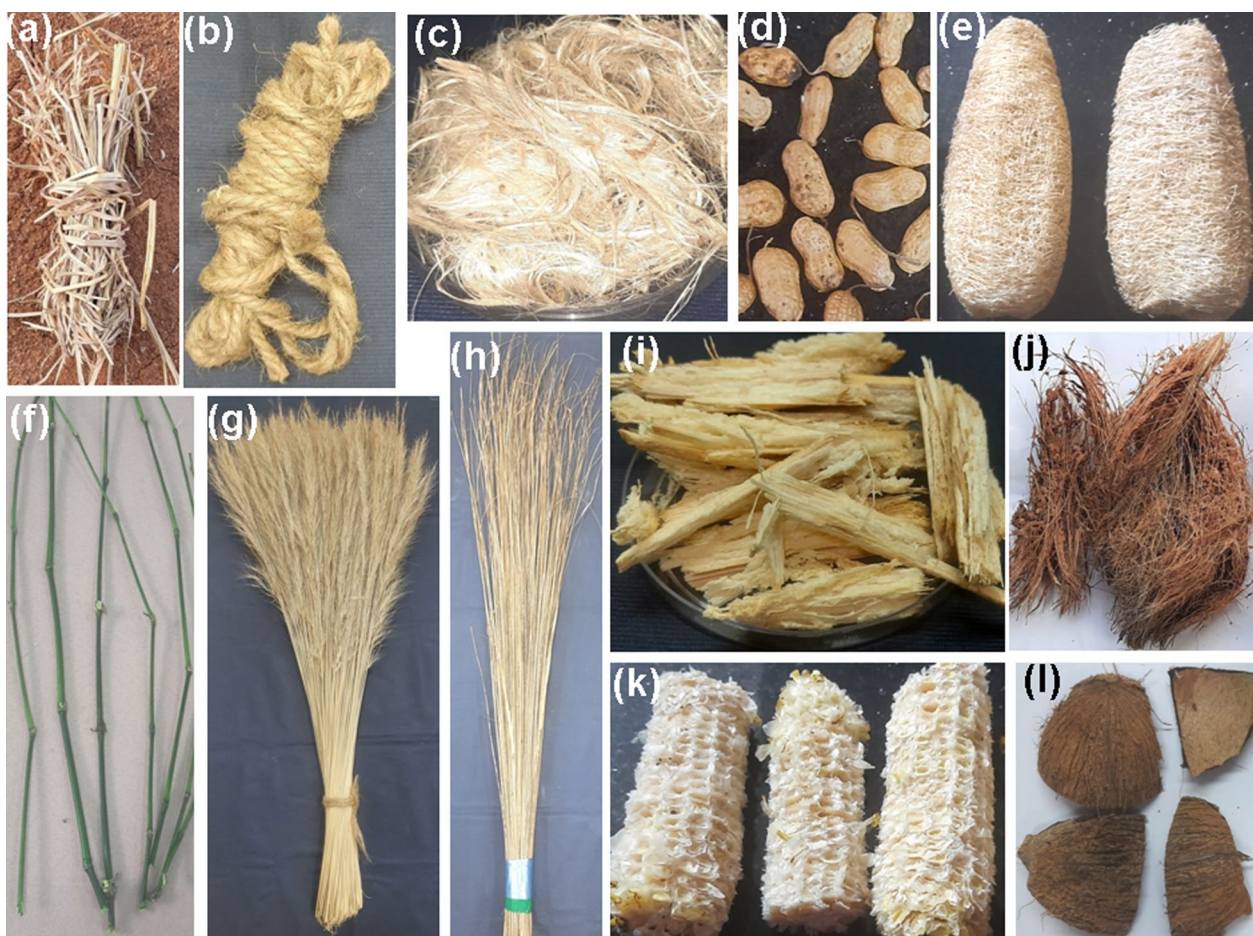


Fig. 1 Photographs of Indian traditional, natural scrubbers and scrappers used for dish wash cleaning, **a** paddy straw, **b** jute fiber, **c** roselle fiber, **d** groundnut shells, **e** luffa sponge, **f** bamboo stem sticks, **g** thorn grass broom, **h** coconut broom, **i** sugarcane bagasse, **j** coconut coir, **k** corn cob and **l** coconut shells

in terms of their classification, properties, importance and applications. Since pre-Harappan civilization, India has used renewable, natural materials, such as saponiferous fruits (*Sapindus* sp., *Acacia concinna*, *Phyllanthus emblica*) as hair cleanser, detergent and dish wash cleaner. This shows the country's rich biodiversity and the long standing, hygienic customs that are ingrained in Indian culture (Kora 2022).

Due to their inherent antibacterial properties, copper and brass utensils are frequently used in traditional Indian homes, helping to maintain clean and hygienic dishes (Singh and Goel 2021). Because natural cleaning products and agricultural residues are readily available, affordable and environmentally friendly, the habit of using them for dishware cleaning has been passed down through the generations in many Indian communities, particularly in rural regions (Lawagon and Amon 2019). The community knowledge and expertise contribute to the preservation of these ecofriendly cleaning practices

(Wisetkomolmat et al. 2021). With a growing focus on sustainable living and environmental consciousness, there is a renewed interest in using natural dish wash cleaning materials in contemporary Indian homes as well. Nowadays, a lot of people are looking for environmentally responsible alternatives to commercial, store bought detergents and traditional Indian cleaning techniques serve as an inspiration for adopting natural and sustainable methods for dishwashing and household cleaning.

The primary ingredients of dish wash cleaners are surfactants (anionic, cationic, non-ionic), builders, emulsifiers, stabilizers, additives, etc. (Nhat Do et al. 2019; Tsai et al. 2008). In India, Indian standard (IS) IS 6047:2009 adopted by the Bureau of Indian Standards (BIS) prescribes the requirements for scouring products for utensil cleaning based on the product form, such as bar, liquid, paste and powder. The standard incorporated various limits, such as retention on 250 μm sieve (%), active matter (%), reserve alkalinity (mL), alcohol insoluble

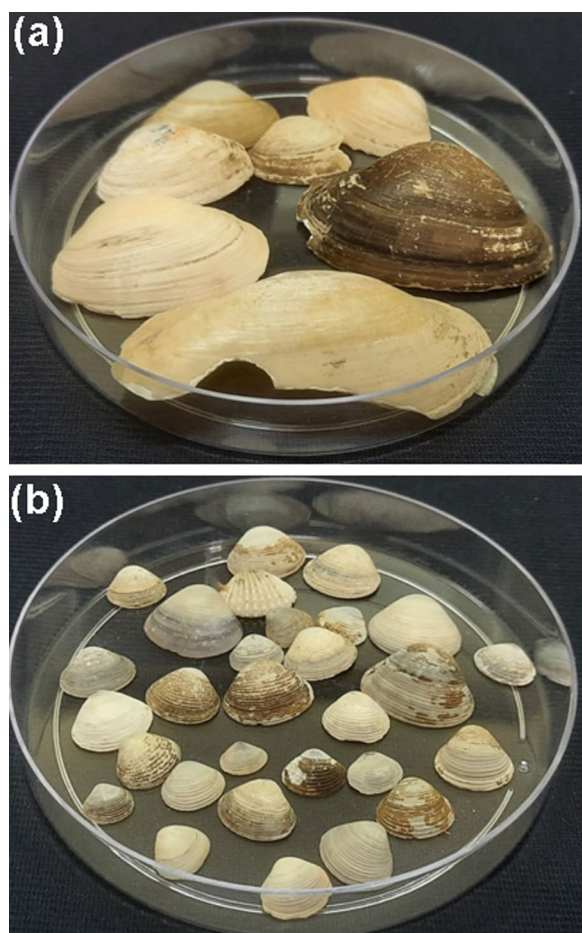


Fig. 2 Photographs of calcareous, bivalve shell-based kitchen utensil scrappers, **a** mussels and **b** clams

matter (%), moisture and volatile matter content at 105 °C (%), lather (mL), cleaning efficiency, tough soil cleaning (%) and surface damage. The list of suggested builders and additives (borax, boric acid, perborate, aluminate, carbonate, bicarbonate, hypochlorite, silicate, meta-silicate, sulfate, sulfonate, phosphate, pyrophosphate, tripolyphosphate, hexametaphosphate, titanium oxide, sodium chloride, sodium hydroxide, ethanol amine, ethylene diamine tetra acetic acid, lauric acid, citric acid, kaolin, dolomite, zeolite, sorbitol, starch, polyethylene glycol, glycerine, liquid paraffin oil, urea, hydrogen peroxide), colors and perfume are also given (Standards 2021).

Concerns have been raised regarding the antimicrobial preservative triclosan, which is a common ingredient in commercial dish washing solutions. These concerns stem from the preservative’s residual concentration on dish-ware, its interaction with chlorinated water, which can lead to the formation of trihalomethane, sunlight-induced chlorinated dioxin formation and the development of triclosan resistance in microbes (Tsai et al. 2008). Furthermore, phosphate-induced eutrophication of aquatic bodies such as lakes, ponds, rivers and estuaries is not caused by natural dish wash cleaners (Kora et al. 2019; Van Hoof et al. 2017; Tusseau-Vuillemin 2001). Another antimicrobial preservative, paraben (methyl, ethyl, propyl, butyl, benzyl) and alkanolamines and ethanolamine (mono, di, tri) found in household cleaners function as endocrine-disrupting compounds (EDC) (Eriksson et al. 2008; Gluberman et al. 2016). The commercial dish wash cleaners are known to contain potential human carcinogenic byproducts, contaminants and solvents such as 1,4-dioxane. It is formed during the synthesis of ethoxy-lated surfactants and has limited biodegradability (Hayes

Table 1 The list of different plants, in terms of their common name, scientific name, taxonomic family, used parts and used forms as scrubbers and scrappers

Common name	Scientific name	Taxonomic family	Used parts	Used forms
Paddy	<i>Oryza sativa</i>	Poaceae	Straw (node, internode, leaf blade)	Direct, bunch, broom
Sugarcane	<i>Saccharum officinarum</i>	Poaceae	Bagasse	Direct
Corn	<i>Zea mays</i>	Poaceae	Cob	Direct
Bamboo	<i>Bambusa</i> sp.	Poaceae	Stem	Direct, bunch, broom
Thorn grass	<i>Aristida setacea</i>	Poaceae	Stem and panicle inflorescence	Direct, broom
Tiger grass	<i>Thysanolaena latifolia</i>	Poaceae	Stem and panicle inflorescence	Direct, broom
Toddy palm	<i>Borassus flabellifer</i>	Arecaceae	Leaves, leaf midveins	Direct, broom
Coconut	<i>Cocos nucifera</i>	Arecaceae	Fruit mesocarp fiber/coir, endo-carp, leaf midveins	Direct, cord, rope, pad, brush, broom
Jute	<i>Corchorus olitorius</i> , <i>C. capsularis</i>	Malvaceae	Stem bast fiber	Direct, pad, cord, rope, brush, sponge
Roselle	<i>Hibiscus sabdariffa</i> , <i>H. cannabinus</i>	Malvaceae	Stem bast fiber	Direct, cord, rope
Agave	<i>Agave</i> sp.	Asparagaceae	Leaf fiber	Direct, pad, cord, rope, brush
Banana	<i>Musa</i> × <i>paradisica</i>	Musaceae	Pseudostem bast fiber	Direct, pad, cord, rope
Luffa	<i>Luffa aegyptiaca</i> , <i>L. acutangula</i>	Cucurbitaceae	Fruit mesocarp fiber	Direct, pad, sponge
Groundnut	<i>Arachis hypogea</i>	Fabaceae	Fruit pericarp/shell	Direct



Fig. 3 Photographs of Indian traditional, natural abrasives used for dish wash cleaning, **a** black soil, **b** red soil, **c** *Multani mitti*, **d** red ochre, **e** sand, **f** pebbles, **g** crystal salt, **h** lime stone powder and **i** brick powder

et al. 2022). Additionally, there is no microplastic contamination, in contrast to plastic scrubbers (Kora 2019b).

In both developed and developing nations, regular use of household dish wash detergents and cleaners has been attributed to localized eczema/atopic contact dermatitis/allergic contact dermatitis and irritation on hands and skin in home makers, domestic workers, kitchen workers, nursing staff, children, etc. (Austoria et al. 2010; Grammer-West et al. 1996; Rungta 2015; Eriksson et al. 2008). The detergent-induced skin irritation potential of different Indian laundry and dish wash household detergents was investigated using 24 h screening patch test. The study revealed varying levels of erythema, scaling and edema in terms of total irritancy score (Austoria et al. 2010). Some of the ingredients found in household dish wash cleaners are known to exhibit toxicity toward marine bioluminescent symbiotic bacteria (*Aliivibrio fischeri*), crustaceans (*Daphnia magna*, *Artemia*), freshwater zebra fish (*Danio rerio*). They are used as model test

organisms for various toxicological assays and suspected carcinogens (Nhat Do et al. 2019).

Main text

Natural dish wash cleaning materials used in India

Although convenience and marketing have made modern dish washing soaps and detergents more widely available in cities, the paradigm has shifted in favor of natural dish wash cleaning materials that are free of synthetic chemicals, compostable, biodegradable, plastic free, handmade, locally sourced and packaged with no waste. In the fight against pollution and climate change, this might result in the resurgence of conventional alternative cleaning materials in the future. Both commercial and traditional dish wash cleaners are available and also made in a variety of forms, such as fibrous (coir), sponge (luffa), bunch, thread, brooms, pads, scrub, brush, bar, powder (ash), paste and liquid (Earthbits.com 2023). Based on surface, texture, chemical composition and applicability, the natural dish wash cleaning materials can be classified under



Fig. 4 Photographs of Indian traditional, natural abrasives used for dish wash cleaning, **a** rice husk, **b** rice bran, **c** rice starch, **d** wheat starch, **e** corn starch, **f** saw dust, **g** wood ash, **h** dung ash, **i** rice husk biochar, **j** charcoal, **k** egg shells and **l** tamarind seeds

six categories such as scrubbers and scrappers, abrasives, degreasers, deodorizers, biosurfactants and combination cleaners.

Scrubbers and scrappers

Natural plant cleaning materials with large, coarse surfaces and abundant in cellulose such as paddy straw, sugarcane bagasse, corn cob, bamboo stem sticks, stem and panicle inflorescence brooms of thorn grass (*Aristida setacea*) and tiger grass (*Thysanolaena latifolia*), leaf and leaf midvein brooms (toddy, coconut), plant fibers (coconut, jute, roselle, agave, banana), luffa, coconut shells, groundnut shells (Kora 2019b, 2022; Niveditha and Yadav 2016; Da-Costa-Rocha et al. 2014) are used as scrubbers for kitchen utensils, countertops and walls (Fig. 1). Additionally, animal materials especially calcareous shells of bivalve mollusks (mussel, oyster, clam) and chitinous exoskeletons of crustaceans (crab) are used for scrapping the milk residues and soiled utensil surfaces (Fig. 2). For instance, natural luffa sponge also known as cleaning sponge obtained from the dried fibrous fruit mesocarp of sponge gourd

species (*Luffa aegyptiaca*, *L. acutangula*) is widely used as kitchen sponges for cleaning utensils, counter tops, tables, etc., and as bath sponge and scrub (Wisetkornmolmat et al. 2021; Eenadu 2023a). Certain materials are occasionally preferred for use in particular cleaning applications. For example, rice straw is used for scrubbing rice cooked clay pots, while coconut and thorn grass brooms for scrubbing cast iron and clay pots. The scrubbers can be used either directly or made into various forms such as pads, brushes, scrubs, bunches, cords, ropes and brooms (coconut, toddy, thorn grass, Tiger grass) (Earthbits.com 2023).

The list of various plants along with their common name, scientific name, taxonomic family, usable parts and used forms as scrubbers and scrappers are given in Table 1. Scrubbing involves physical mechanical action requiring force to remove dirt, grime and food residues from the kitchen utensil and countertop surfaces. The friction created by the scrubs in the form of pad, brush, sponge and broom against the surface being cleaned is helpful in dislodging and lifting the food particles and stains.

Table 2 The list of different traditional cleaning abrasives, in terms of their common name, Indian names, chemical constituents and cleaning applicability

Common name	Indian names	Chemical constituents	Cleaning applicability
Soil (black, red)	<i>Nalla matti, erra matti</i>	Minerals, organic matter, water	General soiled kitchenware, copperware
Fullers' earth	<i>Multani mitti</i>	Montmorillonite	Greasy kitchenware
Red ochre	<i>Gairika</i>	Hematite (α Fe ₂ O ₃) and aluminum silicate	Brassware
Sand	<i>Isuka</i>	Silicon dioxide	General soiled kitchenware
Pebbles	<i>Gulaka rallu</i>	Silicon dioxide	Food residues
Crystal salt	<i>Kallu uppu</i>	Sodium chloride	Copper, brass and silverware
Lime (shell, lime stone)	<i>Gulla sunnam, rathi sunnam</i>	Calcium oxide	Soot, tar, greasy and stained glass and silverware
Brick	<i>Ituka podi</i>	Silica, alumina, lime, magnesia	General soiled kitchenware
Rice husk	<i>Vari ooka</i>	Cellulose, lignin, silica	General soiled kitchenware
Bran (rice, wheat, corn),	<i>Thoudu</i>	Non-starch polysaccharide, protein, fat and water	Aluminumware
Starch (rice, wheat, corn)	<i>Vari pindi, god-huma pindi, jonna pindi</i>	Amylose and amylopectin	Greasy kitchenware
Sawdust	<i>Rampapu pottu</i>	Cellulose, lignin	General soiled kitchenware
Ash (wood, dung)	<i>Karra budida, kachika</i>	Potassium carbonate, potassium hydroxide	Copper and silverware
Rice husk ash	<i>Vari ooka budida</i>	Amorphous silica, alumina, carbon	Aluminum, copper and brassware
Charcoal	<i>Boggu</i>	Carbon, hydrogen, oxygen	Soiled kitchenware
Rice husk biochar	<i>Nalla</i>	Silica, iron	Aluminum, copper and brassware
Tamarind seeds	<i>Chinta ginjala podi</i>	Carbohydrate, protein, fat, crude fiber	General soiled kitchenware
Egg shells	<i>Guddu penkulu</i>	Calcium carbonate	General soiled kitchenware

Abrasives

The majority of natural abrasives used in dish washing are powders or particles with a rough or gritty texture. They work by abrasive action for removing dirt, stains and stubborn food residues from surfaces such as kitchen utensils, ovens, sinks and countertops without requiring physical effort and force. Commonly used traditional abrasive dish wash cleaners in India, include soil (black, red), natural clay (multani mitti, red ochre/*gairika*), sand, pebbles (*gulaka rallu*), crystal salt (known as *kallu uppu* in Telugu language) (Aguirre 2022), lime (shell, lime stone) (Yenugu 2014), brick powder, rice husk (Wisetkomolmat et al. 2021), bran (rice, wheat, corn), starch (rice, wheat, corn) (Aguirre 2022), sawdust (Lawagon and Amon 2019), ash (wood, dung, rice husk) (Balasubramanyan 2021; Lawagon and Amon 2019), rice husk biochar (*nalla*) (Lawagon and Amon 2019), charcoal, egg shell powder, tamarind seed powder, etc. (Figs. 3 and 4).

Certain abrasives are specifically used for thorough cleaning; for example, *Multani mitti* (Fullers' earth) is used as a natural skin and hair cleanser and as a cleaner for greasy kitchenware cleaner due to its abrasive and high oil and grease absorption qualities; lime (calcium oxide) is used for soot, tar, grease and stain removal from glass, glass chimney and silverware due to its alkaline and abrasive nature (Yenugu 2014); rice bran is employed for aluminum vessel cleaning because of its abrasion, oil

and grease absorption and polishing properties; salt is employed for polishing copper, silverware (Aguirre 2022), starch is utilized for greasy dishware washing due to oil absorptive character (Aguirre 2022) and ash is used for silverware polishing due to its abrasion, absorption and detergent action attributed to potassium carbonate and potassium hydroxide presence (Balasubramanyan 2021; Lawagon and Amon 2019), etc. In India, ash obtained from wood, dung and rice husk, and charcoal are also utilized as dentifrice (Sekhar 1961). Moreover, the red ochre known as *gairika* is used as a dentifrice in a number of Indian Ayurvedic toothpaste and tooth powders. The list of many traditional cleaning abrasives, in terms of their common name, Indian names, chemical constituents and cleaning applicability are given in Table 2.

Degreasers

Organic acid rich, sour tasting materials, such as tamarind fruit mesocarp/pulp (fresh, dried), *Citrus* fruit mesocarp and juice; fruit pulp and juice of mango, Indian gooseberry (*amla*), star gooseberry, tomato, Carandas plum (*vakkaya*), leafy greens of tamarind (*chinta chiguru*), roselle (*gongura*), garden sorrel (*chukka kura*), creeping wood sorrel (*pulichinta*); curd, sour butter milk are the frequently used traditional, natural degreasers (Figs. 5 and 6) (Balasubramanyan 2021; Kora 2019b; Wisetkomolmat et al. 2021; Eenadu 2023c; Aguirre

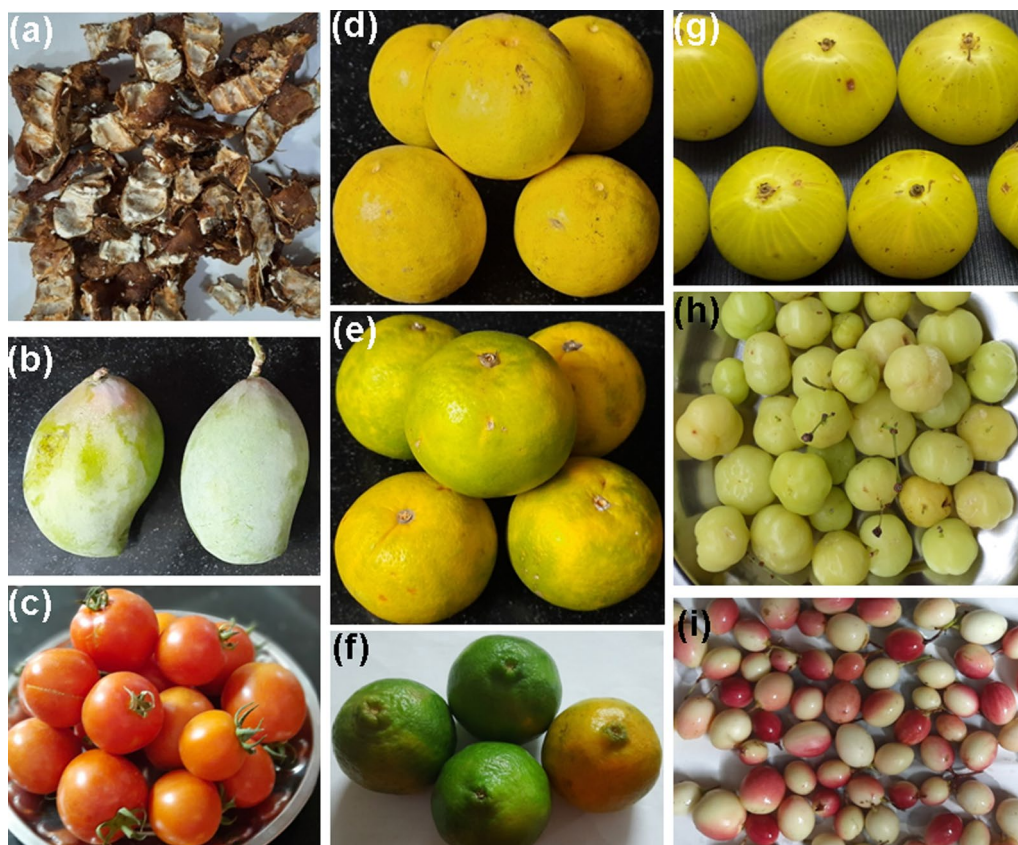


Fig. 5 Photographs of Indian traditional, natural acidic degreasers used for dish wash cleaning, **a** tamarind, **b** mango, **c** tomato, **d** lemon, **e** sweet lime, **f** sweet orange, **g** Indian gooseberry, **h** star gooseberry and **i** Carandas plum

2022). *Citrus limon* (lemon), *C. limetta* (sweet lime) and *C. reticulata* (sweet orange) are the three *Citrus* fruits of the Rutaceae family that are most frequently used for degreasing (Kora 2022; Aguirre 2022). The natural acidic materials that are abundant in organic acids, including citric acid, acetic acid, tartaric acid, oxalic acid, malic acid, ascorbic acid, fumaric acid, lactic acid, etc., serve as effective degreasers. The organic acids are used to remove and dissolve grease, tough stains, mineral deposits and odors from clay, aluminum, stainless steel (SS),

copper, brass and silver kitchenware and are inhibitory to microbial growth (Aguirre 2022). Through physical and chemical processes known as dissolution and emulsification, the degreasers break down the molecules of grease, fat, oil and mineral deposits and stains. This makes it simpler to remove the residues from kitchen utensil surfaces by rinsing them with water (Georgiana Ileana and Gabriel Lucian 2018; Stratford and Eklund 2003). Also, starchy rice water known as *ganji* functions as a degreaser (Kora 2020b). The list of various degreasers,

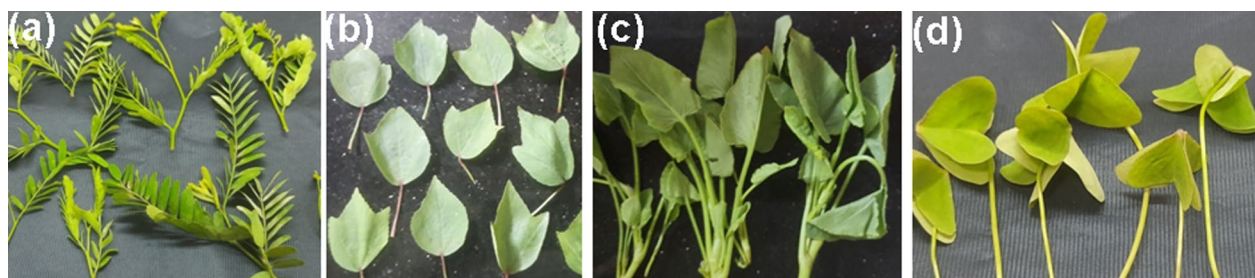


Fig. 6 Photographs of Indian traditional, natural leaf green degreasers used for dish wash cleaning, **a** tamarind, **b** roselle, **c** garden sorrel and **d** creeping wood sorrel

Table 3 The list of different degreasers, in terms of their common name, Indian names, scientific name, taxonomic family, source and chemical constituents

Common name	Indian names	Scientific name	Taxonomic family	Source	Chemical constituents
Tamarind	Chinta, imli	<i>Tamarindus indica</i>	Fabaceae	Fruit mesocarp	Malic acid, tartaric acid
Lemon	Nimma, nimbu	<i>Citrus limon</i>	Rutaceae	Fruit mesocarp	Citric acid
Sweet lime	Battayi, mitha nimbu	<i>C. limetta</i>	Rutaceae	Fruit mesocarp	Citric acid
Sweet orange	Kamala, Nagpur orange	<i>C. reticulata</i>	Rutaceae	Fruit mesocarp	Citric acid
Mango	Mamidi, aam	<i>Mangifera indica</i>	Anacardiaceae	Fruit mesocarp	Malic acid, citric acid
Indian gooseberry	Rathi usiri, amla	<i>Phyllanthus emblica</i>	Phyllanthaceae	Fruit mesocarp	Ascorbic acid, citric acid
Star gooseberry	Chinna usiri	<i>Phyllanthus acidus</i>	Phyllanthaceae	Fruit mesocarp	Ascorbic acid, citric acid
Tomato	Tamata, tamatar	<i>Lycopersicon esculentum</i>	Solanaceae	Fruit pulp	Citric acid, malic acid
Carandas plum	Vakkaya, karonda	<i>Carissa carandas</i>	Apocynaceae	Fruit pulp	Ascorbic acid, citric acid
Tamarind	Chinta chiguru	<i>Tamarindus indica</i>	Fabaceae	Leaves	Malic acid, tartaric acid
Roselle	Gongura	<i>Hibiscus sabdariffa</i> , <i>H. cannabinus</i>	Malvaceae	Leaves	Citric acid, malic acid, tartaric acid, ascorbic acid
Garden sorrel	Chukka kura	<i>Rumex acetosa</i>	Polygonaceae	Leaves	Oxalic acid
Creeping wood sorrel	Pulichinta	<i>Oxalis corniculata</i>	Oxalidaceae	Leaves	Oxalic acid, ascorbic acid

in terms of their common name, Indian names, scientific name, taxonomic family, source and chemical constituents, are given in Table 3.

Deodorizers

Peels from a variety of *Citrus* fruits and seeds of drumstick (*Moringa oleifera*) are commonly used to clean

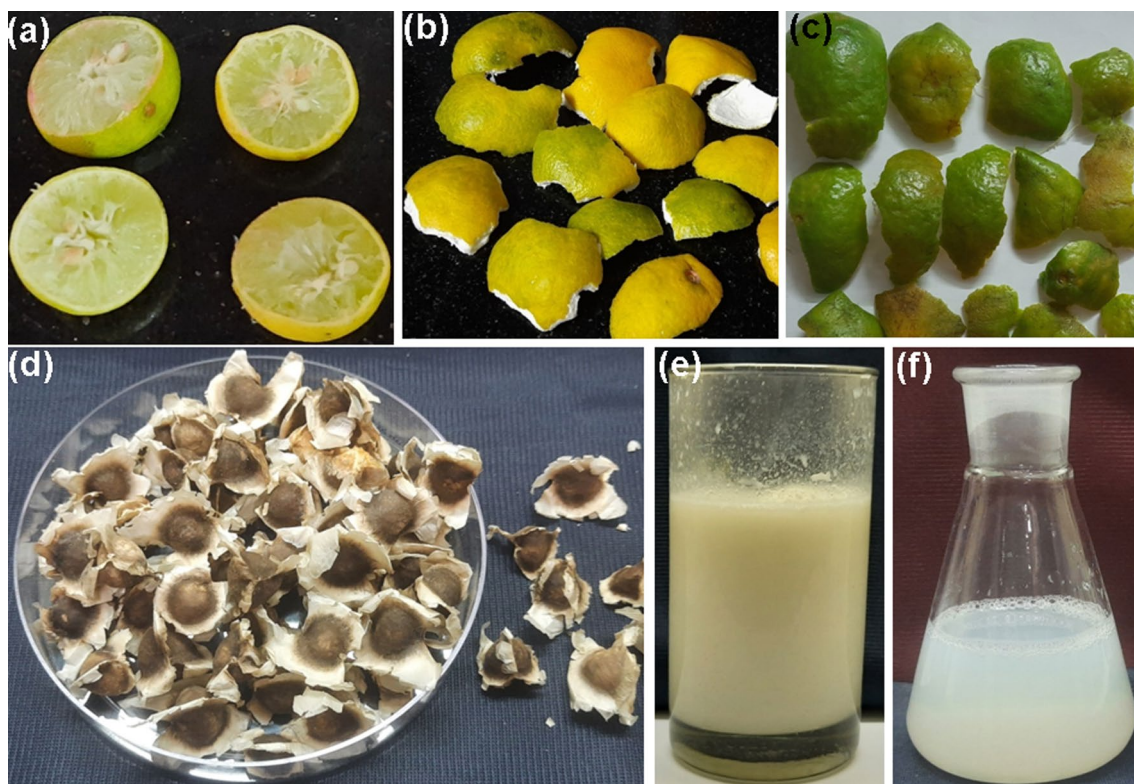


Fig. 7 Photographs of Indian traditional, natural deodorizers used for dish wash cleaning; peels of **a** lemon, **b** sweet lime and **c** sweet orange; **d** drumstick seeds, **e** sour butter milk and **f** starchy rice water

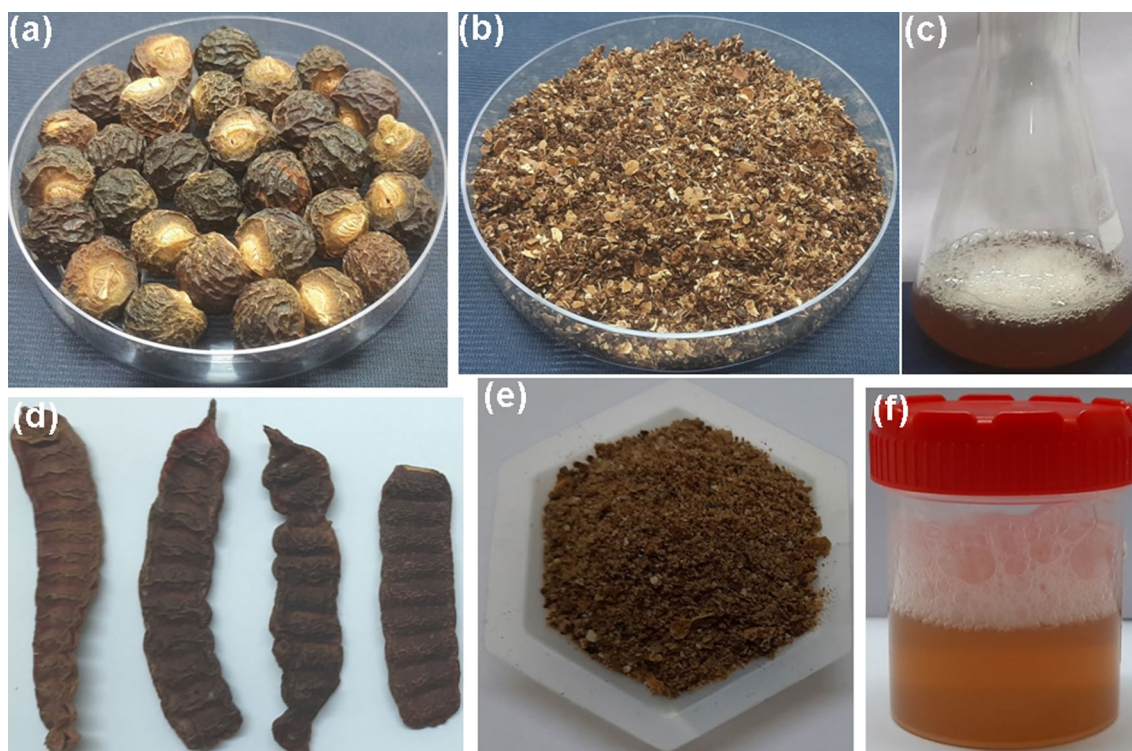


Fig. 8 Photographs of Indian traditional, natural saponin biosurfactants used for dish wash cleaning, **a** soapnut fruits, **b** soapnut fruit powder, **c** soapnut fruit aqueous extract, **d** soap pod fruits, **e** soap pod fruit powder and **f** soap pod fruit aqueous extract

and remove odors from kitchen vessels which are used for rinsing, cooking and storing fish, meat and fish- and meat-based curries, respectively (Srinivasan 2019). As the *Citrus* peels are enriched with flavonoids, saponins, organic acids, antimicrobial essential oils (d-limonene), etc., they aid in degreasing, disinfection of cookware in addition to deodorization and imparting pleasant smell (Kora 2022). Furthermore, a range of materials are utilized to eliminate odors from glass, clay, aluminum, brass, copper and SS kitchen vessels. These materials include crystal salt, wood ash (*karra budida*), dung ash (*kachika*), rice bran, sour butter milk, starchy rice water (*ganji*), fermented idli and dosa batter, etc. (Fig. 7) (Srinivasan 2019). The soiled and smelly cookware is deodorized using a combination of degreasers (*Citrus* fruits), plant saponin biosurfactants (Bengal gram), scrubs (coconut coir) and abrasives (ash). For instance, odor from clay cooking pots can be eliminated by combining *Citrus* peels with Bengal gram seed powder (Eenadu 2023b).

Biosurfactants

For centuries, Indian people utilized plant saponin biosurfactants, which are derived from various parts (leaves, flowers, fruits, fruit pericarp, seeds) of plants that belong to the Sapindaceae (*Sapindus* sp.) and

Fabaceae (*Senegalia rugata*, *Vigna radiata*, *Cicer arietinum*, *Albizia amara*, *Senna auriculata*) families as dish wash cleaners, bathing bar, hair cleanser, hair shampoo and laundry detergent (Kora 2022; Nhat Do et al. 2019). The fruits of *Sapindus* sp. (*S. mukorossi*, *S. emarginatus*, *S. trifoliatus*) (Waran and Chandran 2021) and *Senegalia rugata* (Wisetkomolmat et al. 2021) are rich in triterpenoid and other saponins are known as soapnuts and other *shikakai*, respectively. For example, the pericarp/fruit powder, paste and hot and cold aqueous extracts are utilized as a kitchen utensil cleaner, especially as a polisher for silverware, silver and gold jewellery; laundry detergent for delicate, silk and woolen fabrics and hair and body cleanser (Fig. 8) (Kora 2020a, 2022; Rungta 2015; Wisetkomolmat et al. 2021). The saponin abundant seed powder and paste of green gram (*Vigna radiata*) and Bengal gram (*Cicer arietinum*) are used to clean brass, copper utensils, clay pots, silver and gold jewellery. They are also used as a face mask, body soap, and hair cleanser (Fig. 9) (Kora 2022; Eenadu 2022; SimplyDipti.com 2019). The leaf paste and leaf and flower aqueous extracts of *Albizia amara* and *Senna auriculata* known as *arappu* and *tangedu* in Tamil and Telugu Indian languages, respectively, are also rich in

saponins and are widely exploited as hair cleanser and dish wash cleaner in rural India (Fig. 10) (Tamilselvi et al. 2018). The peels/pericarps of *Citrus* sp. fruits and fruits of Indian gooseberry (*Phyllanthus emblica*) also contain saponins which are also exploited as dish wash cleaners (Fig. 7a–c) (Kora 2022).

Plant saponins have many noteworthy properties that make them suitable for use as sustainable dish wash cleaners. These include their natural availability, renewability, low cost, simple extraction, mass production amenability, superior stability at changeable conditions, low critical micellar concentration (CMC) value, biodegradability under aerobic and anaerobic conditions, non-/hypo-human allergenicity, hand biocompatibility, low human and animal toxicity, multifaceted biological activities (antibacterial, antifungal, antioxidant), etc. (Kora 2022; Wisetkomolmat et al. 2021). The saponins show characteristic features of surfactants, including surface tension reduction, foaming, emulsifying and detergent activities. These features enable water to spread and penetrate grease and grime, wet the surfaces, help lift and dissolve dirt and ultimately make rinsing easier (Rungra 2015; Wisetkomolmat et al. 2021; Kora 2022). The list of different traditional saponin biosurfactant cleaners, in terms of their common name,

Indian names, scientific name, taxonomic family and source, are given in Table 4.

Combination

Apart from standalone applications of different natural dish wash cleaners, diverse combinations of scrubbers, scrappers, abrasives, degreasers, deodorizers and biosurfactants are commonly employed in routine use. Examples of such blends are scrub+abrasive (coconut coir+ash/soil), abrasive+degreaser (crystal salt+lemon/tamarind) for copperware (Aguirre 2022; Srinivasan 2019); abrasive+degreaser (crystal salt/red ochre+lemon) for brassware; abrasive+deodorizer (crystal salt+ *Citrus* peels), abrasive+biosurfactant (wood ash+ *shikakai*) (Srinivasan 2019), degreaser+degreaser (tamarind+lemon) for brass and copperware (SimplyDipti.com 2019); deodorizer+biosurfactant (*Citrus* peels+Bengal gram) for clay pots (Eenadu 2023b; Srinivasan 2019), etc., are a few to list.

Importance and implications

Compared to commercial, manmade surfactants and dish wash cleaners, the important characteristics of natural organic and saponin biosurfactant dish wash



Fig. 9 Photographs of Indian traditional, natural saponin biosurfactants used for dish wash cleaning, **a** green gram seeds, **b** green gram seed powder, **c** Bengal gram seeds and **d** Bengal gram seed powder

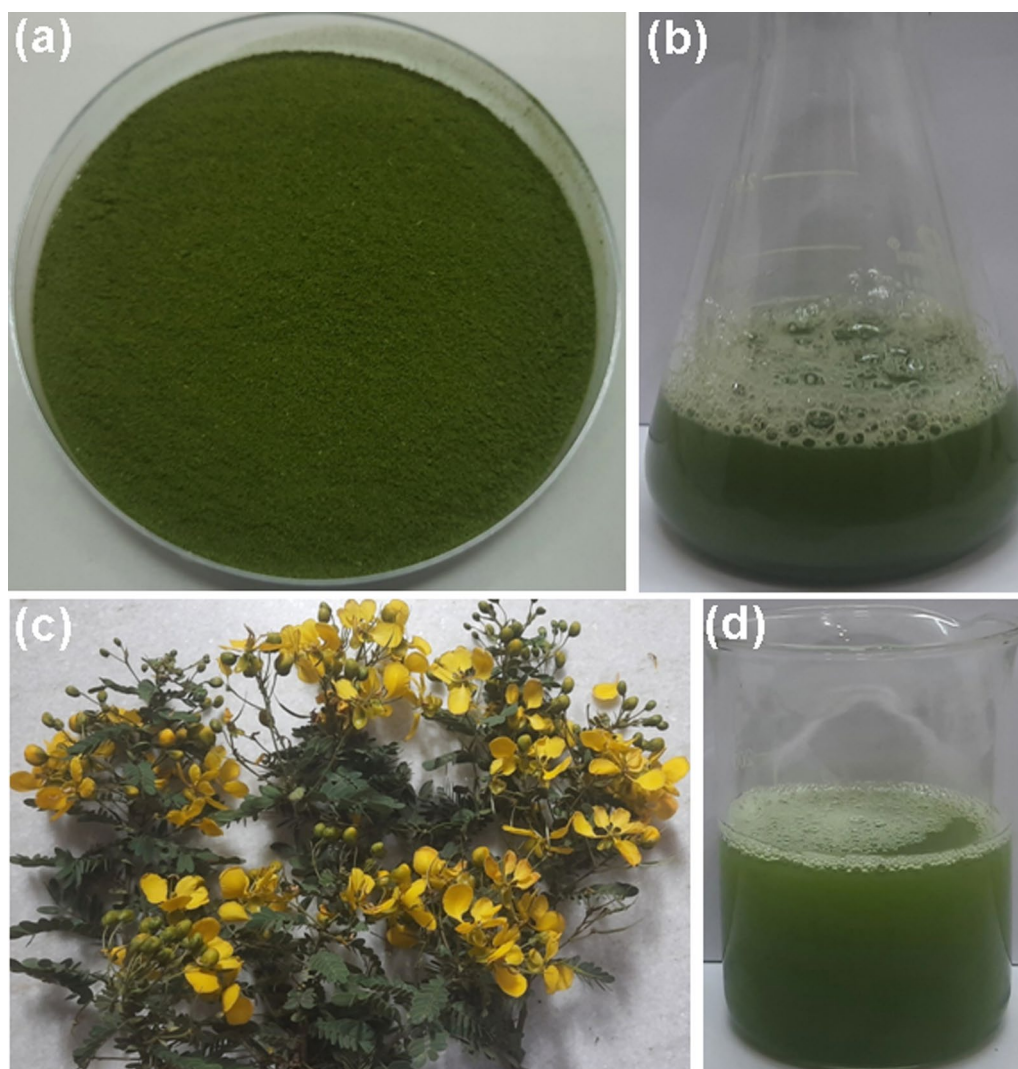


Fig. 10 Photographs of Indian traditional, natural saponin biosurfactants used for dish wash cleaning; bitter *Albizia* **a** leaf powder and **b** aqueous leaf extract; and Tanner's *Cassia* **c** leaves and flowers and **d** aqueous leaf extract

Table 4 The list of different traditional saponin biosurfactant cleaners, in terms of their common name, Indian names, scientific name, taxonomic family and source

Common name	Indian names	Scientific name	Taxonomic family	Source
Soapnut	<i>Kunkudu, reetha</i>	<i>Sapindus mukorossi, S. emarginatus, S. trifoliatus</i>	Sapindaceae	Fruit pericarp
Soap pod	<i>Shikakai, kantavalli</i>	<i>Senegalia rugata</i>	Fabaceae	Fruit pericarp
Green gram	<i>Pesalu, mung</i>	<i>Vigna radiata</i>	Fabaceae	Seeds
Bengal gram	<i>Sanaga, besan</i>	<i>Cicer arietinum</i>	Fabaceae	Seeds
Bitter Albizia	<i>Arappu, Krishna siris</i>	<i>Albizia amara</i>	Fabaceae	Leaves
Tanner's <i>Cassia</i>	<i>Tangedu, avarai</i>	<i>Senna auriculata</i>	Fabaceae	Leaves
Indian gooseberry	<i>Rathi usiri, amla</i>	<i>Phyllanthus emblica</i>	Phyllanthaceae	Fruit
Lemon	<i>Nimma, nimbu</i>	<i>Citrus limon</i>	Rutaceae	Fruit pericarp
Sweet lime	<i>Battayi, mitha nimbu</i>	<i>C. limetta</i>	Rutaceae	Fruit pericarp
Sweet orange	<i>Kamala, Nagpur orange</i>	<i>C. reticulata</i>	Rutaceae	Fruit pericarp

cleaners are their natural availability, affordability, renewability, biocompatibility, biodegradability, minimal environmental and human toxicity; hypo-human allergenicity, etc. (Kora 2022; Rungta 2015; Le Guenic et al. 2019; Waran and Chandran 2021). They are sustainable in terms of local resource utilization, fossil fuel independency, no greenhouse gas emission, no air and water pollution, low carbon footprint, etc. (Wisetkomolmat et al. 2021). The utilization of natural dish wash cleaners offers several benefits, such as absence of phosphate release and nutrient loading into the water bodies; no eutrophication, no oxygen depletion in aquatic bodies, no fill kill, no habitat destruction thus leading to better water quality. These materials support sustainable consumption patterns and promote the conservation of terrestrial and marine ecosystems. In addition to the reduction of plastic packaging waste and preservation of natural resources and cultural heritage; exploitation of natural dish cleaner encourages innovation and supports local community and economy. The use of renewable and natural cleaning materials aligns with several United Nations (UN) Sustainable Development Goals (SDG), including Goal 6 (clean water and sanitation), Goal 9 (industry, innovation and infrastructure), Goal 12 (responsible consumption and production), Goal 13 (climate action), Goal 14 (life below water) and Goal 15 (life on land) (Waran and Chandran 2021).

Conclusions

The use of renewable, natural, and traditional dishwashing cleaning materials in India aligns with the principles of sustainability, environmental conservation and cultural preservation, making it a valuable and meaningful practice in the country's cleaning practices. The present review on traditional dish wash cleaners used in India is apt in the current time in terms of several factors such as global shift toward sustainability and circular economy; cultural preservation, waste reduction, biodiversity conservation, increased consumer awareness, public health concerns arising from Covid pandemic, education and awareness on sustainable living practices, stringent regulatory guidelines and policy changes; global climate summits and commitments such as Paris agreement; corporate and industry initiatives toward social responsibility, advancements in research. However, more and systematic studies are envisaged such as sanitization efficiencies of traditional cleaners toward foodborne pathogens (Lee et al. 2007), cleaning and bacterial survival in natural scrubbers, sponges and brushes (Møretro et al. 2021), compatibility with various materials, metals, delicate surfaces; skin care and alkaline lime handling precautions; bulk scale production, method standardization

for saponin isolation and purification; mixed saponin-based cleaner development, biodegradability, toxicity assessment of saponin biosurfactants on algae, fungi, mollusks (snails), invertebrates, fish and other aquatic life forms (Nhat Do et al. 2019); permissible saponin release limits into aquatic streams, ecolabelling of saponin and other natural dish wash cleaning products for consumer informed choice, economic feasibility (Waran and Chandran 2021; Kora 2022), etc.

Abbreviations

BIS	Bureau of Indian Standards
EDC	Endocrine-disrupting compounds
IS	Indian standard
SDG	Sustainable development goals
UN	United Nations

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